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Bleach Decontamination in the Forensic Laboratory and at the Crime Scene: Investigating the Efficacy of DNA Damage in Native vs. Naked Templates

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In forensic casework, there are three major factors which significantly impact successful recovery of a DNA profile from evidence, including low-quality (degraded) DNA, low quantity DNA, and the presence of endogenous or environmental inhibitors. DNA damage/degradation is inherent in an evidentiary sample when it arrives in the laboratory. The degree and spectrum of DNA damage present depends on the environment to which it was exposed and the length of exposure time. In the natural environment, ultraviolet light, acidity, heat, and humidity all contribute to various forms of damage in the molecular structure of DNA. In addition to environmental insult, chemicals can be used to damage DNA.

Household/commercial bleach (6% NaOCl, sodium hypochlorite) degrades DNA through oxidative damage, production of chlorinated base products, and cleavage of DNA strands (breaking it into smaller and smaller fragments). The presence of these lesions significantly impacts the ability to generate a full genetic profile from forensic evidence. In fact, knowledge of the damaging effect of bleach on DNA is the basis for its use in forensic laboratories to clean workbenches and prevent cross-contamination of samples between cases. Additionally, bleach is used intentionally by criminals to clean up crime scenes and destroy DNA evidence. A previous study demonstrated that bleach has a decreased effect on native DNA that is still encompassed within a body fluid (compared to naked DNA that has already been extracted) [1]. This research project expanded on the previous study, with an increased sample size and expanded data set. Numerous variables were tested, including dried blood, wet (uncoagulated) blood, native DNA, naked DNA, and varying concentrations of bleach. DNA in whole human blood (native conformation) and extracted (naked) DNA were immersed in two different concentrations of bleach for a 1-hour exposure period. Solid-phase DNA extraction and human-DNA-specific quantification revealed that sufficient quantities of DNA were recovered for STR typing, for both native and naked DNA templates and after exposure to both bleach concentrations (with higher DNA recovery from native samples vs. naked templates).

The ultimate goal of this research was to investigate differences in the efficacy of bleach in generating damage to native and naked DNA templates. Results indicate that current decontamination methods using bleach in the laboratory may not be as effective as perceived (at least for DNA complexed with other materials). Additionally, it is often assumed that if a criminal has cleaned a crime scene with bleach, any underlying DNA evidence has been destroyed (which might prevent crime scene technicians from swabbing the area and submitting samples to laboratories for DNA analysis). Hence, this research will impact the forensic science community by demonstrating that amplifiable DNA often can still be recovered from human blood that has been exposed to bleach, especially if the DNA is still encompassed in its native tissue upon initial exposure (i.e., still protected within the body fluid). Decontamination of laboratory workbenches

may actually be partially due to physical removal of DNA from a surface ("wiping away") as opposed to chemical destruction or damage.

References

[1]Ambers A, Turnbough M, Benjamin R, King J, Budowle B (2014). Assessment of the role of DNA repair in damaged forensic samples. *International Journal of Legal Medicine* 128(6): 913-921. doi:10.1007/s00414-014-1003-3.